

AIR BLANKET GAS CONSERVATION UNIT FOR CHEMICAL CONTAINERS AND METHOD OF USING THE SAME

Technical Field

An air blanket gas conservation unit and overflow protector for chemical dispensing systems is disclosed.

Background Art

High purity chemical containers, when put in operation, may implode/explode due to the constant liquid level changes within the containers during suction and refilling of the containers. An inert gas, such as high purity N₂, blankets the vapor space of the chemical containers. The inert gas blanket helps to maintain a slight minimum positive pressure within the enclosed container, alleviating this implosion/explosion concern. The inert gas also helps to maintain the quality/purity of the chemicals within the container.

In the semiconductor, photovoltaic, LCD-TFT, or flat panel display fabrication industries, chemical and slurry delivery systems are used to deliver bulk liquid chemical and slurry to the tools through suction of liquid from chemical containers. High purity nitrogen gas is piped into the containers to try to minimize the danger of working with these "corrosive/poisonous" and/or flammable chemicals. The high purity nitrogen gas may also prevent damage and contamination to the environment. In many systems, the inert gas continuously flows over the chemical, resulting in the use of high volumes of inert gas, as well as the associated cost of the high volumes of inert gas.

Currently, there are various methods used for blanketing chemical containers with inert gases. As shown in **FIG 1**, chemical dispense systems **100** may use a gas blanket manifold **101** to provide an inert gas, such as N₂, to chemical drums **110** and tanks **111**. The gas blanket manifold **101** receives the inert gas from an inert gas source **102**. The gas blanket manifold **101** distributes the inert gas to the chemical drums **110** and tanks **111**. A pump **105** in the chemical dispense system **100** transfers chemicals from the chemical drum **110** to

the tank 111. Over pressurization or overfill of the chemical tanks 111 may cause chemical to flow back through the gas blanket manifold 101 where it is vented to exhaust 103. This creates a dangerous situation. It may also result in environmental issues when the chemicals are regulated by environmental agencies.

Various methods have been designed to either conserve the nitrogen gas used for blanketing or to prevent over pressure relief. However, currently none of the methods encompasses the entire suite of inert gas conservation, inert gas blanketing, pressure relief, and the safety aspect in the event of any chemical overflow.

Summary of Invention

Disclosed are air blanket gas conservation units. The units include a hollow body with a first end and a second end. A gas inlet fitting through the hollow body receives the air blanket gas. One or more gas outlet fittings through the hollow body distribute the air blanket gas to chemical containers. A first check valve is located at the first end of the hollow body. The units include a second check valve having a lower pressure relief setting than the first check valve. The second check valve has a diameter at least 1.5 times larger than each of the one or more gas outlet fittings. The units include a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings. The units may include one or more of the following aspects:

- The hollow body being one piece;
- The hollow body being two pieces;
- the buffer zone having a volume sufficient to prevent chemical overflow through the first check valve;
- the buffer zone having a length ranging between approximately 6 inches and approximately 20 inches;
- the buffer zone having a length ranging between approximately 6 inches and approximately 15 inches;

- the buffer zone having a length ranging between approximately 8 inches and approximately 12 inches;
- the buffer zone having a diameter ranging between approximately 2 inches to approximately 20 inches;
- 5 • the buffer zone having a diameter ranging between approximately 2 inches to approximately 15 inches;
- the buffer zone having a diameter ranging between approximately 3 inches to approximately 8 inches;
- 10 • the gas inlet fitting and the one or more gas outlet fittings being located near the first end of the hollow body;
- a pressure gauge measuring a pressure of the air blanket gas in the hollow body;
- the first check valve being fluidly connected to an exhaust;
- 15 • the first check valve being fluidly connected to an inert gas recapture system;
- the second check valve being located at the second end of the hollow body;
- the second check valve being located on the hollow body below the gas outlet fittings;
- 20 • the second check valve being fluidly connected to a drain;
- the second check valve being fluidly connected to a solvent recovery system;
- a pressure regulator connected to the gas inlet fitting to control the pressure of the air blanket gas;
- 25 • the hollow body being a J-shaped tube, with the first end of the hollow body at an end of a long segment of the J-shape and the second end of the hollow body at an end of a short segment of the J-shape, further comprising a second drain at a nadir of the J-shape;
- the hollow body being a J-shaped tube, with the first end of the hollow body at an end of a short segment of the J-shape and the second end of the hollow body at a an end of a long segment of the J-shape, further comprising a second drain at a nadir of the J-shape; and
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- the hollow body being a vertically-oriented and cylinder-shaped tube, with the first check valve being located on a top end of the tube and the second check valve being located on a bottom end of the tube.

Also disclosed are chemical dispense systems for delivering chemicals to a semiconductor process tool. The chemical dispense systems include a cabinet containing a gas inlet directly connected to a source of an inert gas; one or more gas outlets directly connected to piping used to distribute the inert gas to chemical containers; one or more chemical inlets; one or more chemical outlets; a pump connecting the one or more chemical inlets to the one or more chemical outlets; a vent; a drain; and any of the air blanket gas conservation units disclosed above.

Also disclosed are methods of using the air blanket gas conservation units disclosed above to prevent chemical overflow to exhaust and to conserve the air blanket gas. Piping is connected to (a) one or more chemical containers and (b) to the one or more gas outlet fittings of the air blanket gas conservation unit. The first check valve is connected to exhaust or to an inert gas recapture system. The second check valve is connected to a drain or solvent recovery system. The source of the air blanket gas is connected to the gas inlet fitting. The air blanket gas is distributed through the air blanket gas conservation unit to the one or more chemical containers. The disclosed methods may include one or more of the following aspects:

- monitoring a pressure inside the air blanket gas conservation unit;
- adjusting the pressure of the air blanket gas using a pressure regulator connected between the gas inlet fitting and the source of the air blanket gas;
- recapturing air blanket gas that escapes through the first check valve in the inert gas recapture system; and
- recovering chemical that escapes through the second check valve in the solvent recovery system.

In one aspect, there is provided an air blanket gas conservation unit comprising:

- a. a hollow body with a first end and a second end;

b. a gas inlet fitting through the body, the gas inlet fitting receiving the air blanket gas;

c. one or more gas outlet fittings through the body, the one or more gas outlet fittings distributing the air blanket gas;

5 d. a first check valve located at the first end of the body;

e. a second check valve having a lower pressure relief setting than the first check valve, the second check valve having a diameter at least 1.5 times larger than each of the one or more gas outlet fittings; and

10 f. a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings.

In another aspect, there is provided a chemical dispense system for delivering chemicals to a semiconductor process tool, the chemical dispense system comprising

a cabinet containing:

15 i. a gas inlet directly connected to a source of an inert gas;

ii. one or more gas outlets directly connected to piping used to distribute the inert gas to chemical containers;

iii. one or more chemical inlets;

iv. one or more chemical outlets;

20 v. a pump connecting the one or more chemical inlets to the one or more chemical outlets;

vi. a vent;

vii. a drain; and

25 viii. an air blanket gas conservation unit, the air blanket gas conservation unit comprising:

a. a hollow body with a first end and a second end;

b. a gas inlet fitting through the body, the gas inlet fitting connected to the gas inlet;

30 c. one or more gas outlet fittings through the body, the one or more gas outlet fittings connected to the one or more gas outlets;

d. a first check valve located at the first end of the body, the first check valve connected to the vent;

e. a second check valve having a lower pressure relief setting than the first check valve, the second check valve having a diameter at least 1.5 times larger than each of the one or more gas outlet fittings, the second check valve connected to the drain; and

5 f. a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings.

In another aspect, there is provided a method of using an air blanket gas conservation unit to prevent chemical overflow to exhaust and to conserve the air blanket gas, the air blanket gas conservation unit comprising

- 10 a. a hollow body with a first end and a second end;
- b. a gas inlet fitting through the body;
- c. one or more gas outlet fittings through the body;
- d. a first check valve located at the first end of the body;
- e. a second check valve having a lower pressure relief setting than the
- 15 first check valve, the second check valve having a diameter at least 1.5 times larger than each of the one or more gas outlet fittings; and
- f. a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings;

the method comprising

- 20 1. connecting piping to (a) one or more chemical containers and (b) to the one or more gas outlet fittings of the air blanket gas conservation unit;
2. connecting a first check valve to exhaust or to an inert gas recapture system;
- 25 3. connecting the second check valve to a drain or solvent recovery system;
4. connecting a source of the air blanket gas to the gas inlet fitting; and
5. distributing the air blanket gas through the air blanket gas
- 30 conservation unit to the one or more chemical containers.

Notation and Nomenclature

Certain abbreviations are used throughout the following description and claims, and include: the abbreviation “PP” refers to PolyPropylene; the abbreviation “PE” refers to PolyEthylene; the abbreviation “HDPE” refers to High

Density PE; the abbreviation "PVDF" refers to PolyVinylDiFluoride (PVDF); the abbreviation "SS" refers to Stainless Steel; and the abbreviation "PFA" refers to perfluoroalkoxy.

Brief Description of Drawings

For a further understanding of the nature and objects of the present invention, reference should be made to the following detailed description, taken in conjunction with the accompanying graphs, in which like elements are given the same or analogous reference numbers, and wherein:

FIG 1 is an illustration of a prior art chemical dispense system and gas blanket manifold;

FIG 2 is an illustration of one embodiment of the disclosed air blanket gas conservation unit;

FIG 3 is an illustration of a second embodiment of the disclosed air blanket gas conservation unit;

FIG 4 is an illustration of a third embodiment of the disclosed air blanket gas conservation unit;

FIG 5 is an illustration of a fourth embodiment of the disclosed air blanket gas conservation unit; and

FIG 6 is an illustration of a chemical dispense system incorporating the disclosed air blanket gas conservation unit.

Description of Preferred Embodiments

Disclosed are air blanket gas conservation units that conserve the quantity of inert blanketing gas used to maintain the purity of chemicals in the semiconductor, photovoltaic, LCD-TFT, or flat panel display fabrication industries. The disclosed air blanket gas conservation unit addresses chemical overflow concerns through its ability to contain and channel the overflow chemical to the chemical drain or recycling system. At the same time, the disclosed air blanket gas conservation gas unit conserves the air blanket gas by incorporating check valves to restrict unnecessary gas flow to exhaust and drain without producing the danger of pressure build up.

The air blanket gas conservation unit has a hollow body with a first end and a second end, such as a hollow tube, sphere, box, or any other hollow hemisphere-, cone-, prism-, or polyhedron-shaped container. The hollow body may be formed from one or more pieces. The hollow body forms an air-tight and pressure resistant enclosure suitable for containing the air blanket gas. The hollow body of the air blanket gas conservation unit may be made of any material suitable for use with the chemicals the inert gas is used to blanket. The body may be made of PolyVinylChloride (PVC) because PVC is compatible with a majority of the chemicals used in the semiconductor, photovoltaic, LCD-TFT, or flat panel display fabrication industries. The PVC body may be clear to permit inspection of the inside of the container. Alternatively, the hollow body may be made of PolyPropylene (PP), PolyEthylene (PE), High Density PE (HDPE), PolyVinylDiFluoride (PVDF), perfluoroalkoxy (PFA), or Stainless Steel (SS).

As shown in **FIGS 2-5**, the hollow body of the air blanket gas conservation unit has a first end and a second end, such as a PVC pipe with female adaptors covering the first and second ends to produce an air-tight and pressure resistant enclosure. The hollow body may be composed of one or multiple separate pieces. The PVC pipe and female adapters may be clear.

A hole is bored through the hollow body of the air blanket gas conservation unit and a gas inlet fitting is installed. The gas inlet fitting connects the hollow body to piping containing an inert gas that serves as the air blanket gas. Exemplary inert gases include argon, nitrogen, helium, etc. Any suitable gas-tight fitting may be used as the gas inlet fitting. The gas inlet fitting may connect to the inert gas source using a male or female connectors. The gas inlet fitting may be installed through the hole in the hollow body using threading, crimps, or barbs, or any other leak resistant connection suitable for use at the target pressures. Alternatively, the gas inlet fitting may be welded or glued to the hollow body. For example, the gas inlet fitting may utilize female threading, which can be screwed into the hole through the wall of the body of the air blanket gas conservation unit. Alternatively, the gas inlet fitting may utilize a male connection that can be welded to the body surrounding the hole through the wall of the body. The gas inlet fitting may be any material compatible with the inert gas and the chemicals the inert gas is used to blanket. Exemplary gas inlet fittings include Jaco or Swagelok® brand

fittings. The gas inlet fitting may be American Iron and Steel Institute (AISA) 316 SS, PP, PVDF, or PFA. For corrosive chemicals, PP, PVDF or PFA is preferred.

The inert gas may be supplied through the gas inlet fitting to inside the hollow body of the air blanket gas conservation unit from a pressure regulated supply source. Alternatively, as shown in **FIG 5**, a pressure regulator may be connected to the gas inlet fitting to control the pressure of the inert gas delivered into the air blanket gas conservation unit.

One or more holes are bored through the hollow body of the air blanket gas conservation unit and one or more gas outlet fittings are installed. The gas outlet fittings connect the body of the air blanket gas conservation unit to piping used to distribute the inert gas to chemical containers in a chemical system. As a result, the inert gas introduced to the body of the air blanket gas conservation system by the gas inlet fitting is distributed to chemical containers through the gas outlet fittings. The chemical containers include any containers that require an air blanket inert gas, such as drums, day tanks, or bulk tanks. Like the gas inlet fitting, the gas outlet fitting may be any suitable gas-tight fitting.

The gas inlet fitting and gas outlet fittings may be located near each other on the body of the air blanket gas conservation unit. Preferably, the gas inlet fitting is located above the gas outlet fittings. This arrangement permits any liquid overflow from the chemical containers through the gas outlet fittings into the air blanket gas conservation unit to flow through the second check valve without contaminating the gas inlet fitting. The gas inlet fitting and gas outlet fittings may also be located near the first end of the hollow body.

The air blanket gas conservation unit contains two check valves (also known as non-return valves). Any suitable check valves may be used in the air blanket gas conservation unit, including ball check valves, diaphragm check valves, swing check valves, stop-check valves, lift-check valves, in-line check valves, or duckbill valves. Initial testing of the invention utilized GF in-line check valves, with the spring modified to obtain the desired pressure relief setting. One of ordinary skill in the art will recognize that the spring may be trimmed to lower the pressure relief setting or expanded to increase the pressure relief setting. The check valves may be connected to either the body of the air blanket gas conservation unit or female adapters connected to the body using any form of

connection mechanism, such as threading, welding, or glue having sufficient strength to maintain air-tight connection at elevated pressures.

The first check valve minimizes or prevents loss of the inert gas. However, should the chemical containers become over-pressurized, the inert gas may be released through the first check valve. The first check valve may be fluidly connected to an exhaust or to an inert gas recapture system. As most blanketing systems have a pressure of approximately 5 psig, the pressure relief setting (also known as the cracking pressure) of the first check valve may be set between approximately 2.5 and approximately 5 psig. One of ordinary skill in the art will recognize that any changes in the blanketing pressure and/or container size may require alterations to the pressure relief setting of the first check valve. Initial testing of the invention utilized GF 5 psig check valve having a 1 inch diameter with the break pressure modified to 2.5 psig.

The second check valve has a lower set pressure than that of the first check valve. For example, when the first check valve is set at a pressure relief setting of approximately 2.5 psig, the second check valve may be set at a pressure relief setting of approximately 1 psig. As a result, any chemical flow from the drum, day tank, or bulk tank into the air blanket gas conservation unit due to over-pressurization or improper operation flows through the lower pressure second check valve to either a solvent recovery system or drain. The second check valve may therefore be fluidly connected to a drain, waste containment, or chemical recapture system. The diameter of the second check valve is at least 1.5 times larger than each of the gas outlet fittings. Therefore, any chemical overflow due to over-pressurization or miss-operation flows through the second check valve faster than it flows through the first check valve. Initial testing of the invention utilized GF 5 psig check valve having a 1.25 inch diameter with the break pressure modified to 1 psig.

One of ordinary skill in the art will recognize that the first check valve is preferably located on the hollow body above the second check valve. This arrangement permits any liquid overflow from the chemical containers through the gas outlet fittings into the air blanket gas conservation unit to flow through the second check valve without contaminating the first check valve. However, as the break pressure of the second check valve is lower than that of the first check

valve, the air blanket gas conservation unit would still function if the first check valve were located on the hollow body below the second check valve.

As shown in **FIGS 2, 3, and 5**, the first check valve may be located through the end cap at the first end of the hollow body and the second check valve may be located through the end cap at the second end of the hollow body. Alternatively, as shown in **FIG 4**, the first check valve may be located through the end cap at the first end of the hollow body and the second check valve may be located on the hollow body, provided a sufficient buffer zone exists between the second check valve and the inlets/outlets. One of ordinary skill in the art will recognize that the locations of the first and second check valves will vary depending on the shape of the body of the air blanket gas conservation unit.

The air blanket gas conservation unit contains a buffer zone within the hollow tube between the second check valve and the gas outlet fittings. The buffer zone has a volume sufficient to prevent chemical overflow through the first check valve. The buffer zone may have a length ranging between approximately 6 inches and approximately 20 inches and a diameter ranging between approximately 2 inches to approximately 20 inches long. The length and diameter may be greater than 20 inches, providing a larger buffer zone, as long as there is sufficient space in the chemical dispense system. One of ordinary skill in the art will recognize that the size of the air blanket gas conservation unit and its associated buffer zone will be at least partially dictated by the available space in the chemical dispense system.

The hollow body of the air blanket gas conservation unit may be a J-shaped tube formed from two pieces of PVC piping. One of ordinary skill in the art would recognize how to connect the two pieces to be air-tight and pressure resistant. The first end of the hollow body and the first check valve may be located at the end of the long segment of the J-shape and the second end of the hollow body may be located at the end of the short length of the J-shape, as shown in **FIG 2**. Alternatively, the first end of the hollow body and the first check valve may be located at the end of the short segment of the J-shape and the second end of the hollow body at the end of the long length of the J-shape. In these embodiments, the air blanket gas conservation unit may also include a drain located at the nadir of the J-shape. In yet another alternative, the first check valve

may be located at the end of the long segment of the J-shape and the second check valve located at the nadir of the J-shape, as shown in **FIG 4**.

Alternatively, the hollow tube may be vertically-oriented and cylinder-shaped, with the first check valve being located on a top end of the hollow tube and the second check valve being located on a bottom end of the hollow tube, as shown in **FIGS 3 and 5**.

The air blanket gas conservation unit may optionally include a pressure gauge that measures the pressure of the air blanket gas in the hollow tube. The optional pressure gauge may be used to monitor the pressure of the gas blanketing the chemical containers. Any type of pressure gauge may be used, including Bourdon tube, diaphragm, capsule, bellows, piezoresistive strain, capacitive, magnetic, piezoelectric, optical, potentiometric, or resonant pressure gauges. Preferably, the pressure gauge will measure gauge pressures from approximately 0 psig to approximately 7 psig. Initial testing of the invention utilized a Wika Bourdon tube dry case pressure gauge having a 0-10⁵ Pa range and ¼ inch NPT pressure connection.

Exemplary illustrations of the disclosed air blanket gas conservation unit **10** are shown in **FIGS 2-5**. The air blanket gas conservation units **10** include a hollow tube **11** having a first end **12** and a second end **13**. Female adapters (visible, but not numbered) are located at the first end **12** and the second end **13** in **FIGS 2-5**. In **FIGS 2 and 4**, the hollow tube **11** is J-shaped. In **FIGS 3 and 5**, the hollow tube **11** is vertically-oriented and cylinder-shaped.

The air blanket gas conservation units **10** include a first check valve **14** located through the end cap at the first end **12** of the hollow tube **11**. As discussed previously, the first check valve **14** provides an exhaust path for over-pressurized gas. The first check valve **14** also reduces unnecessary inert gas waste. The first check valve **14** may be connected to exhaust or an inert gas recapture system (not shown).

The air blanket gas conservation units **10** include a second check valve **15**. In **FIGS 2, 3 and 5**, the second check valve is located through the end cap at the second end **13** of the hollow tube **11**. In **FIG 4**, the second check valve **15** is located at the nadir of the J-shape. As discussed above, the second check valve

15 provides an outlet for any chemical overflow. The second check valve **15** may be connected to a solvent recovery system or drain (not shown).

The air blanket gas conservation units **10** include a gas inlet fitting **16** into which the inert gas flows. The units **10** include three gas outlet fittings **17 a-c**. In **FIGS 2-4**, the three gas outlet fittings **17 a-c** are located on the same side of the hollow tube **11**. In **FIG 5**, two **17 a-b** of the gas outlet fittings are located on the opposite side of the hollow tube **11** from one **17 c** of the gas outlet fittings. The inert gas flows through the gas outlet fittings **17 a-c** through piping (not shown) connected to the containers (not shown) requiring the inert gas blanket. One of ordinary skill in the art will recognize that more or less gas outlet fittings may also be used, depending on the number of containers requiring a blanket of inert gas.

The air blanket gas conservation units **10** include a buffer zone **18** between the second check valve **15** and the gas outlet fittings **17 a-c**. The units **10** include the optional pressure gauge **19** to monitor internal pressure. In **FIG 2**, the unit **10** includes the optional drain **20** located at the nadir of the J-shape. In **FIG 5**, the unit **10** includes the optional pressure regulator **21**.

The air blanket gas conservation units connect the source of an inert gas to piping used to distribute the inert gas to chemical containers in a chemical system. As shown in **FIG 6**, the air blanket gas conservation unit **10** replaces the gas blanket manifold **101** of the chemical dispense system **100** of **FIG 1**.

To use the air blanket gas conservation unit **10**, suitable gas and chemical tolerant piping is connected to one or more chemical containers (**110** or **111**) containing chemicals and to one or more gas outlet fittings (**17 a-c**) of the air blanket gas conservation unit (**10**). The second check valve (**15**) is connected to a solvent recovery system or drain (not shown). The source of an inert gas (**102**), such as N_2 , is connected to the gas inlet fitting (**16**). Inert gas then enters the air blanket gas conservation unit (**10**) and flows to the chemical containers (**110**, **111**) through the one or more gas outlet fittings (**17 a-c**). The optional pressure gauge (**19**) may be used to monitor the gas pressure in the air blanket gas conservation unit (**10**). The inert gas may be provided from a pressure regulated source. Alternatively, an optional pressure regulator (**21**) may be used to adjust the gas pressure of the inert gas to approximately 1 psig in the air blanket gas conservation unit (**10**).

During transfer of the chemical from the chemical drum (110) to the chemical tank (111), chemical overflow may occur. Improper operation may also cause the chemical to flow from the chemical tank (111) through the piping into the air blanket gas conservation unit (10). The air blanket gas conservation unit (10) prevents the chemical from flowing to the gas exhaust (103). Instead, the overflow either (a) proceeds directly through the second check valve (15) to the solvent recovery system or drain or (b) remains in the buffer zone (18).

After transfer, the air blanket gas conservation unit (10) maintains the drum (110) and tank (111) under an inert atmosphere. As chemical is distributed from the tank (111) for use in a semiconductor or photovoltaic manufacturing process, the air blanket gas conservation unit (10) provides sufficient inert gas to maintain pressure in the tank (111) and integrity of the chemical remaining in the tank (111).

Examples

The following non-limiting examples are provided to further illustrate embodiments of the invention. However, the examples are not intended to be all inclusive and are not intended to limit the scope of the inventions described herein.

EXAMPLE 1:

A prototype of the disclosed air blanket gas conservation unit was built and tested. The prototype utilized was similar to that depicted in FIG 3. More particularly, the prototype utilized a PVC tube with one Jaco gas inlet fitting and two Jaco gas outlet fittings, a GF 5 psig check valve having a 1 inch diameter with the break pressure modified to 2.5 psig, a GF 5 psig check valve having a 1.25 inch diameter with the break pressure modified to 1 psig, and a Wika Bourdon tube dry case pressure gauge having a 0-10⁵ Pa range and ¼ inch NPT pressure connection.

The prototype was tested on a chemical delivery system. More particularly, the prototype replaced the controlled flow meter in a chemical delivery system. The controlled flow meter had one open end to an exhaust port and multiple lines to various containers for blanketing. The flow meter required a set pressure of 40

psig and a continuous minimum flow rate of 15 lpm. Any improper operation of the chemical delivery system using a flow meter type device may result in discharge of both gas and chemical to the exhaust. Also during normal operation using a flow meter type device, inert gas is constantly discharged through the exhaust.

When the flow meter was replaced with the prototype, the set pressure was reduced from 40 psig to 1 psig. No minimum flow rate was required because flow only occurs on an "as needed" basis, resulting in a significant reduction in inert gas usage. When simulating overflow of chemical into the prototype, the chemical flowed into the buffer zone at 12 lpm. When the pressure gauge was slightly above 1 psig, the chemical started to flow through the second check valve to the drain. The liquid level in the buffer zone stabilized at about 5 inches in height, but did not flow through the first check valve to exhaust. Using the prototype, inert gas was not released to the exhaust unless the pressure inside the unit rises above 2.5 psi, resulting in savings of inert gas.

EXAMPLE 2:

An orifice manifold with 1 mm orifice that controls air flow and one end pipe connected to an exhaust port was used as the blanketing manifold in a chemical delivery system. The orifice blanketing manifold required a set pressure between 0.8 and 1 psig and a continuous minimum flow rate of 12-15 lpm. Any improper operation of the chemical delivery system using the orifice blanketing manifold may result in gas and chemical discharge to the exhaust. Also during normal operation of the orifice blanketing manifold, inert gas is constantly discharged through the exhaust.

When the orifice blanketing manifold was replaced with the prototype, no minimum flow rate was required because flow only occurs on an "as needed" basis, resulting in a significant reduction in inert gas usage. When simulating overflow of the chemical into the system, the chemical flowed in to the buffer zone at 12 lpm. When the pressure gauge was slightly above 1 psig, the chemical started to flow through the second check valve to the drain. The liquid level in the buffer stabilized at about 5 inches in height, but did not flow through the first check valve to exhaust. Using the prototype, inert gas was not released to the exhaust

unless the pressure inside the unit rises above 2.5 psi, resulting in savings of inert gas.

While embodiments of this invention have been shown and described,
5 modifications thereof can be made by one skilled in the art without departing from
the spirit or teaching of this invention. The embodiments described herein are
exemplary only and not limiting. Many variations and modifications of the
composition and method are possible and within the scope of the invention.
Accordingly the scope of protection is not limited to the embodiments described
10 herein, but is only limited by the claims which follow, the scope of which shall
include all equivalents of the subject matter of the claims.

We claim:

1. An air blanket gas conservation unit comprising:
 - a. a hollow body with a first end and a second end;
 - 5 b. a gas inlet fitting through the body, the gas inlet fitting receiving the air blanket gas;
 - c. one or more gas outlet fittings through the body, the one or more gas outlet fittings distributing the air blanket gas;
 - d. a first check valve located at the first end of the body;
 - 10 e. a second check valve having a lower pressure relief setting than the first check valve, the second check valve having a diameter at least 1.5 times larger than each of the one or more gas outlet fittings; and
 - f. a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings.
- 15 2. The air blanket gas conservation unit of claim 1, wherein the buffer zone has a volume sufficient to prevent chemical overflow through the first check valve.
- 20 3. The air blanket gas conservation unit of claim 2, wherein the buffer zone has a length ranging between approximately 6 inches and approximately 20 inches and a diameter ranging between approximately 2 inches to approximately 20 inches.
- 25 4. The air blanket gas conservation unit of any one of claims 1 to 3, wherein the gas inlet fitting and the one or more gas outlet fittings are located near the first end of the hollow body.
- 30 5. The air blanket gas conservation unit of any one of claims 1 to 4, further comprising a pressure gauge measuring a pressure of the air blanket gas in the hollow body.

6. The air blanket gas conservation unit of any one of claims 1 to 5, wherein the first check valve is fluidly connected to an exhaust.

7. The air blanket gas conservation unit of any one of claims 1 to 6, wherein the second check valve is located at the second end of the hollow body.

8. The air blanket gas conservation unit of any one of claims 1 to 7, wherein the second check valve is fluidly connected to a drain.

9. The air blanket gas conservation unit of any one of claims 1 to 8, further comprising a pressure regulator connected to the gas inlet fitting to control the pressure of the air blanket gas.

10. The air blanket gas conservation unit of claim 8 or 9, wherein the hollow body is a J-shaped tube, with the first end of the hollow body at an end of a long segment of the J-shape and the second end of the hollow body at an end of a short segment of the J-shape, further comprising a second drain at a nadir of the J-shape.

11. The air blanket gas conservation unit of claim 8 or 9, wherein the hollow body is a J-shaped tube, with the first end of the hollow body at an end of a long segment of the J-shape and the second end of the hollow body at a an end of a short segment of the J-shape, further comprising a second drain at a nadir of the J-shape.

12. The air blanket gas conservation unit of any one of claims 1 to 9, wherein the hollow body is a vertically-oriented and cylinder-shaped tube, with the first check valve being located on a top end of the tube and the second check valve being located on a bottom end of the tube.

13. A chemical dispense system for delivering chemicals to a semiconductor process tool, the chemical dispense system comprising
a cabinet containing:

- i. a gas inlet directly connected to a source of an inert gas;
- ii. one or more gas outlets directly connected to piping used to distribute the inert gas to chemical containers;
- iii. one or more chemical inlets;
- iv. one or more chemical outlets;
- v. a pump connecting the one or more chemical inlets to the one or more chemical outlets;
- vi. a vent;
- vii. a drain; and
- viii. an air blanket gas conservation unit, the air blanket gas conservation unit comprising:
 - a. a hollow body with a first end and a second end;
 - b. a gas inlet fitting through the body, the gas inlet fitting connected to the gas inlet;
 - c. one or more gas outlet fittings through the body, the one or more gas outlet fittings connected to the one or more gas outlets;
 - d. a first check valve located at the first end of the body, the first check valve connected to the vent;
 - e. a second check valve having a lower pressure relief setting than the first check valve, the second check valve having a diameter at least 1.5 times larger than each of the one or more gas outlet fittings, the second check valve connected to the drain; and
 - f. a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings.

14. The chemical dispense system of claim 13, wherein the buffer zone has a volume sufficient to prevent chemical overflow through the first check valve.

15. The chemical dispense system of claim 13 or 14, further comprising a pressure gauge measuring a pressure of the air blanket gas in the hollow body.

16. The chemical dispense system of any one of claims 13 to 15, further comprising a pressure regulator connected to the gas inlet fitting to control the pressure of the air blanket gas.

17. The chemical dispense system of any one of claims 13 to 16, wherein the hollow body is a vertically-oriented and cylinder-shaped tube, with the first check valve being located on a top end of the tube and the second check valve being located on a bottom end of the tube.

18. A method of using an air blanket gas conservation unit to prevent chemical overflow to exhaust and to conserve the air blanket gas, the air blanket gas conservation unit comprising

- a. a hollow body with a first end and a second end;
- b. a gas inlet fitting through the body;
- c. one or more gas outlet fittings through the body;
- d. a first check valve located at the first end of the body;
- e. a second check valve having a lower pressure relief setting than the first check valve, the second check valve having a diameter at least 1.5 times larger than each of the one or more gas outlet fittings; and
- f. a buffer zone within the hollow body between the second check valve and the one or more gas outlet fittings;

the method comprising

1. connecting piping to (a) one or more chemical containers and (b) to the one or more gas outlet fittings of the air blanket gas conservation unit;
2. connecting a first check valve to exhaust or to an inert gas recapture system;
3. connecting the second check valve to a drain or solvent recovery system;
4. connecting a source of the air blanket gas to the gas inlet fitting; and
5. distributing the air blanket gas through the air blanket gas conservation unit to the one or more chemical containers.

19. The method of claim 18, further comprising monitoring a pressure inside the air blanket gas conservation unit.

20. The method of claim 19, further comprising adjusting a pressure of the air blanket gas using a pressure regulator connected between the gas inlet fitting and the source of the air blanket gas.

21. The method of claim 18, further comprising recapturing air blanket gas that escapes through the first check valve in the inert gas recapture system.

22. The method of claim 18, further comprising recovering chemical that escapes through the second check valve in the solvent recovery system.